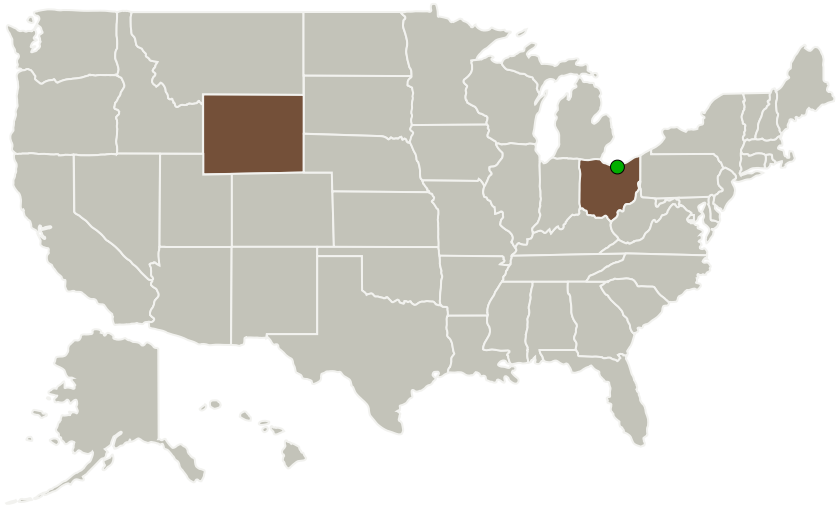
Physics-based Modeling of Foreign Object Damage in Ceramic Matrix Composites, Phase I

Completed Technology Project (2011 - 2011)

Project Introduction

In this Phase I SBIR, Firehole Technologies will develop proof-of-concept modeling framework for a multiscale physics-based modeling tool for predicting foreign object damage in ceramic matrix composites (CMCs). We will accomplish this by adapting the core technology, multicontinuum theory (MCT), from our existing industry-leading software analysis tool, Helius:MCT, to the problem of impact damage in CMCs. Our approach will involve modeling the composite at three levels: constituent level (fiber, matrix, interphase), mesostructure-level (fiber tow architecture), and macrostructure level (impact test of a multi-ply laminate). The mesostructure and macrostructure will be modeled using an explicit finite element analysis code. The constituent level modeling will be carried out using MCT, which permits constituent stresses and strains to be exactly determined from composite-average strain. The objective of the Phase I effort is to develop the modeling framework and compare predicted results with published experimental results. In-depth study of ceramic physics, development of an experimental validation program, and commercialization of the software would be part of a Phase I effort.

Primary U.S. Work Locations and Key Partners



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Organizations Performing Work	Role	Type	Location
Firehole Technologies, Inc.	Lead Organization	Industry Historically Underutilized Business Zones (HUBZones)	Laramie, Wyoming
Glenn Research Center(GRC)	Supporting Organization	NASA Center	Cleveland, Ohio

Primary U.S. Work Locations	
Ohio	Wyoming

Project Transitions

February 2011: Project Start

September 2011: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/138403)*

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Firehole Technologies, Inc.

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

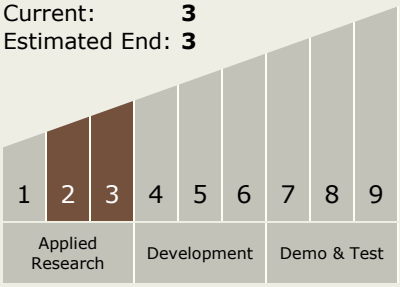
Carlos Torrez

Principal Investigator:

Donald W Robbins

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**



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Technology Areas

Primary:

- TX13 Ground, Test, and Surface Systems
  - TX13.1 Infrastructure Optimization
    - TX13.1.7 Impact/Damage/Radiation Resistant Systems

Target Destinations

The Moon, Mars, Outside the Solar System, The Sun, Earth, Others Inside the Solar System